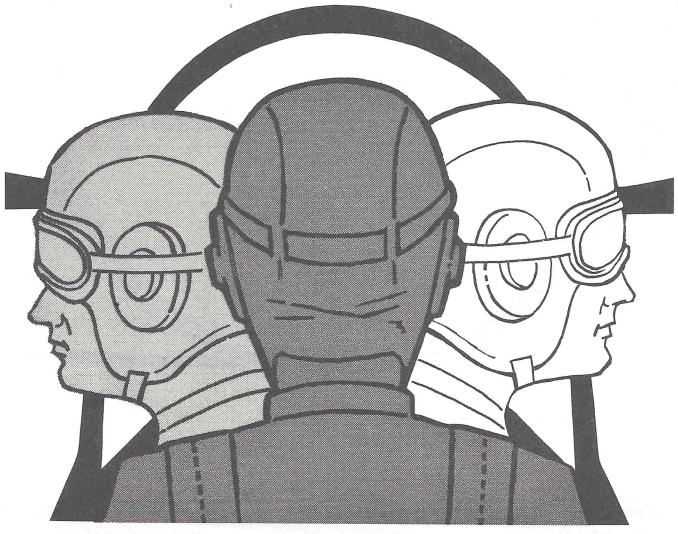
acrobatics

chapter 12

Acrobatics in the broadest sense include all maneuvers not necessary to normal flight. For all practical purposes they may be defined as any maneuver in which the pitch and/or bank exceed 90 degrees or a vertical attitude.

The purpose of teaching you acrobatic maneuvers is to help you develop a more sensitive feel in handling the aircraft and to improve your ability to coordinate the flight controls regardless of attitude. Learning to perform acrobatics skillfully will give you more confidence in your flying ability, help you become familiar with all attitudes of flight, and increase your ability to fly an aircraft at maximum performance. Acrobatics will teach you, moreover, the proper methods of recovering from abnormal attitudes. Though the ability to perform acrobatics is important within itself, the confidence you gain merely from performing them is equally important.

The acrobatic maneuvers you will learn to perform are the Loop, Barrel Roll, Immelmann, Slow Roll, and the Half-roll and Reverse. All of these maneuvers will be performed with

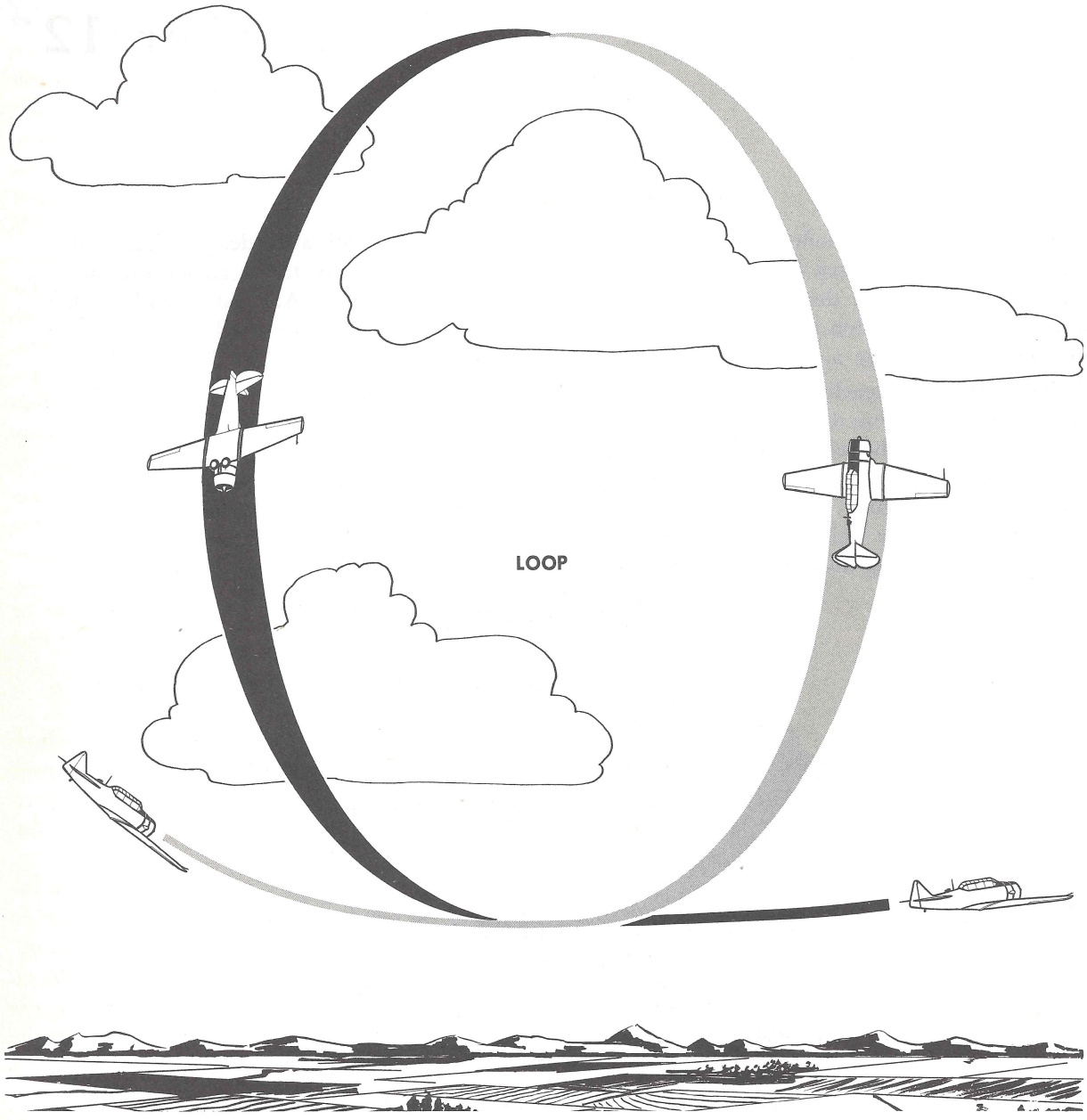


Take a Good Look Around before Beginning Maneuvers

the following power settings and flight conditions:

Gyros caged
Throttle at 25″ Hg
Propeller at 1850 RPM
Mixture lean for smooth operation
Gear and flaps up
Canopy closed
Minimum recovery altitude 5000 feet above terrain

Before setting up the aircraft for acrobatics with these flight conditions, cage your gyros. Always trim the aircraft for straight and level flight at normal cruising speed, not for the acrobatic maneuver.



LOOP

The loop is the first acrobatic maneuver you will learn to perform. It is a 360° turn in the vertical plane; since it is executed in a single plane, the elevators are the basic and main controls. The ailerons and rudder are used for coordination and to maintain directional control.

Begin the maneuver by making at least two 90° clearing turns. To attain the correct airspeed, which is 190 MPH, dive the aircraft through the second clearing turn.

To remain properly oriented, you should select a road or section line for a ground reference. Line the aircraft up with this reference, after making the clearing turns, and try to keep it lined up throughout the loop to help you maintain directional control and stay in the plane of the loop.

When a speed of 190 MPH has been attained, raise the nose slowly and smoothly to the horizon with elevators while holding the wings level with ailerons. Changing airspeeds will naturally require rudder control to maintain directional control. Do not hesitate at the horizon, but increase the back pressure on the stick to maintain a constant rate of movement of the nose throughout the pull-up. When this is done, centrifugal force will cause you to feel a definite seat pressure. Use this seat pressure to help you determine the proper rate of movement of the nose. For example, if there is very little seat pressure, you will know that your rate of pull is not fast enough.

Continue to hold the wings level with the ailerons and maintain directional control with the rudder. When you can no longer see the horizon ahead, look out at the wing tips and keep them equidistant from the horizon. When the wing tips appear to be about vertical to the horizon, move your head straight back until you can see the approaching horizon. Use this new horizon just as you did the other one during the pull-up.

As the inverted position is attained, a very small amount of back-stick pressure should be released; however, continue to maintain a definite seat pressure. This is done to prevent a stall at the low airspeeds encountered in the top of the loop. During this low airspeed range in the pull-up near the top of the loop, and in the inverted position, you should apply right-rudder pressure to prevent torque from pulling the nose of the aircraft away from the plane of the loop; also, use whatever aileron pressure is needed to hold the wings level.

As the nose passes through the horizon and the aircraft enters the dive, you should increase back pressure on the stick to maintain a definite seat pressure and to keep the nose moving at a constant rate so as to raise the nose again to the straight and level flight attitude.

Remember that the elevators are the basic controls used to execute the loop. The ailerons and rudders are used to maintain directional control and coordination. If you pull up too fast, causing the nose to rise too rapidly and build up excessive seat pressure, you will increase the angle of attack too rapidly and may enter a stall. If you pull up too slowly, causing the nose to rise too slowly and fail to maintain a definite seat pressure, a stall will occur before the aircraft reaches the inverted position.

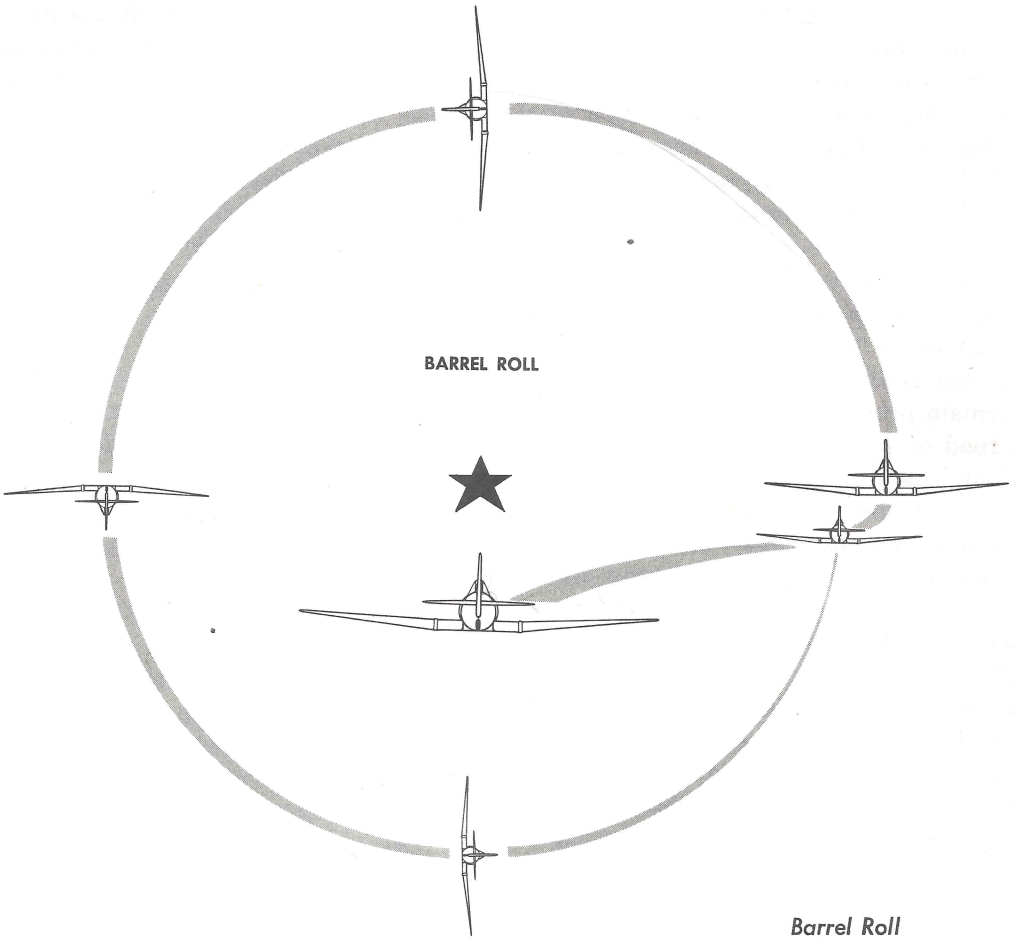
Remember to use back-stick pressures to keep the nose moving at the constant rate and to maintain definite seat pressures throughout the maneuver. It is a good idea to check your altitude before entering the loop and try to recover at the same altitude or higher. In other words, maintain — do not lose — altitude in this maneuver.

BARREL ROLL

A barrel roll is a coordinated roll in which the nose of the aircraft describes a circle around a real or imaginary point on the horizon. Definite seat pressure should be maintained throughout the roll.

The barrel roll should be practiced to the right and left, and there should be little or no loss or gain of altitude during the maneuver.

You should begin the maneuver by performing at least two 90° clearing turns. Attain the initial speed, which is 160 MPH, by diving the aircraft slightly through the second clearing turn.



Barrel Roll

The 160-MPH speed should be attained with the nose directly below the point of reference. Blend stick and rudder pressures to begin a turn opposite to the direction of the desired roll. Keep the nose below the horizon until it has reached a position approximately 20 degrees to the side of the reference point.

At this point begin rolling out of the initial turn and raise the nose simultaneously so that the wings are level just as the nose passes through the horizon. Continue the coordinated stick and rudder pressures, thus causing the nose to continue climbing and the wings to continue banking.

As the wings approach the vertical position, the nose should be at the highest point above the horizon and directly above your reference point. As you approach this position you must relax some of the back-stick pressure and blend in more aileron pressure with the roll. Maintain the same rudder pressures through the vertical position that were used at the 45° position. Time the roll so that the wings become level and the aircraft is in the inverted position just as the nose reaches the horizon. The aircraft should be the same distance on the opposite side of the original point as it was when passing through the horizon at the beginning of the maneuver.

As the nose passes down through the horizon, continue the roll, and, at this point, begin applying increased top-rudder pressure and blend in the back-stick pressure that was relaxed at the top of the maneuver.

As the wings again reach the vertical position, the nose should be the same distance be-

low the point as it was above the point in the first part of the maneuver. Continue the control pressures to make the aircraft roll on up until the wings become level just as the nose reaches the horizon at the same point it passes through at the beginning of the maneuver.

The reason for blending in additional aileron pressure at the vertical position in the first quarter of the roll is to maintain a constant rate of roll. Remember that the nose is rising constantly up to this point, and the airspeed is diminishing. Because of the lowered airspeed, the aileron is less effective than it was at the beginning of the maneuver. This means that the rate of roll will slow down unless more aileron surface is presented to the relative wind; so, by applying and holding added aileron pressure, the rate of roll is held constant.

Back-stick pressure is also relaxed slightly at this same vertical position. Otherwise, if the same amount of back-stick pressure is held when the aircraft is inverted as was initially used to raise the nose to the attitude attained at the vertical position, it would tend to pull the nose too far down in relation to the horizon.

The added top-rudder pressure is applied just after the nose passes through the horizon in the inverted attitude. This compensates for additional aileron drag effect. If the pattern of the maneuver is alright at this point, and you do not want to tighten it up, you may begin releasing a slight amount of aileron pressure and eliminate the excessive aileron drag. Remember that the aileron moved downward into the area of high pressure is the one that is doing the work, and also the dragging. In the barrel roll, the one on the outside of the roll or turn is the one that does the dragging. You will recall that rudder is also used to overcome aileron drag, or as it is sometimes called, adverse yaw.

As the aircraft passes the inverted position, the outside wing becomes more and more a bottom wing (in relation to the ground and horizon). This is the wing with the most aileron drag. At this time, aileron drag plus gravity is trying to pull the nose down. This combination of forces appears in the effect of additional adverse yaw, or aileron drag, and requires additional rudder pressure (or some reduction of aileron pressure) to keep it from pulling the nose down and from the flight path of the maneuver.

The application of additional back-stick pressure at this same point helps to coordinate the roll and to return the nose to the horizon.

These control effects apply to some extent to any rolling acrobatic maneuver; although they may be modified. This should be kept in mind.

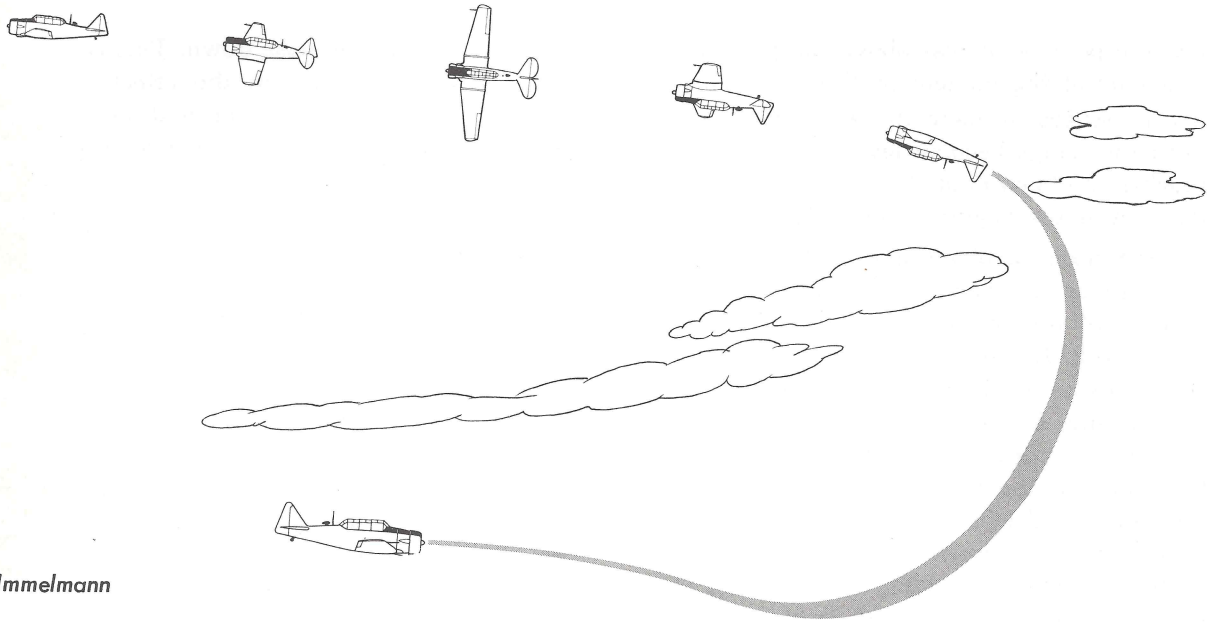
Remember that it is the ailerons that roll the aircraft, and that you must apply sufficient aileron pressure to maintain a constant rate of roll throughout the entire maneuver. Do not attempt to force the roll with the rudder or elevators; they are used only to maintain coordination. The aircraft should remain in balanced or coordinated flight, and definite seat pressures should be maintained throughout the maneuver.

IMMELMANN

The Immelmann turn is a composite maneuver consisting of the first half of a loop followed by a half roll to level flight. This maneuver achieves a 180° change of direction with a gain in altitude.

Once again you must make at least two 90° clearing turns before beginning the maneuver. Attain the initial speed, which is 200 MPH, by diving the aircraft through the second clearing turn.

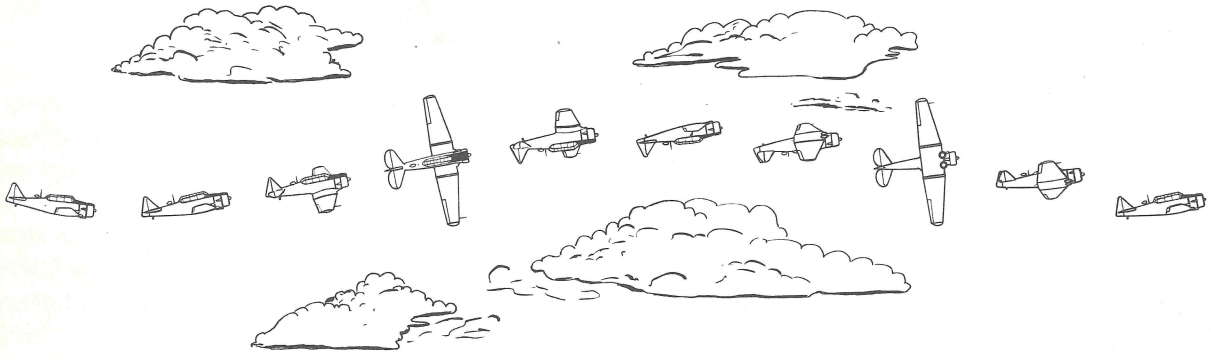
When you reach 200 MPH, raise the nose slowly and smoothly to the horizon with the elevators and hold the wings level with the ailerons. Do not hesitate at the horizon, but increase back-stick pressure and cause the rate of pull-up to increase. Maintain definite seat pressures and keep the nose moving at a constant rate. For this maneuver you should execute your pull-up slightly faster than for the loop. Continue to hold the wings level with the ailerons and maintain directional control with the rudder as in the loop.



Immelmann

When you no longer can see the horizon ahead, look out at both wing tips to see whether they are both the same distance from the horizon. As the wing tips pass the vertical position, look back over your head for the approaching horizon. Continue the loop and when the nose of the aircraft is slightly above the horizon, begin blending a roll with the pull-through; the object here is not to roll on a point, but to roll from inverted to normal straight and level flight without change in direction as the nose is descending to straight and level flight. To start the roll, move the stick in the desired direction of the roll; then follow immediately with rudder in the same direction. In this respect you are actually leading the roll with aileron. It will be necessary to relax the back pressure on the stick slightly as the roll is started. As the bank attitude passes through the vertical and as the aircraft approaches the level-flight attitude, you must begin blending in back-stick pressure and relaxing aileron pressure and maintain directional control with the rudder.

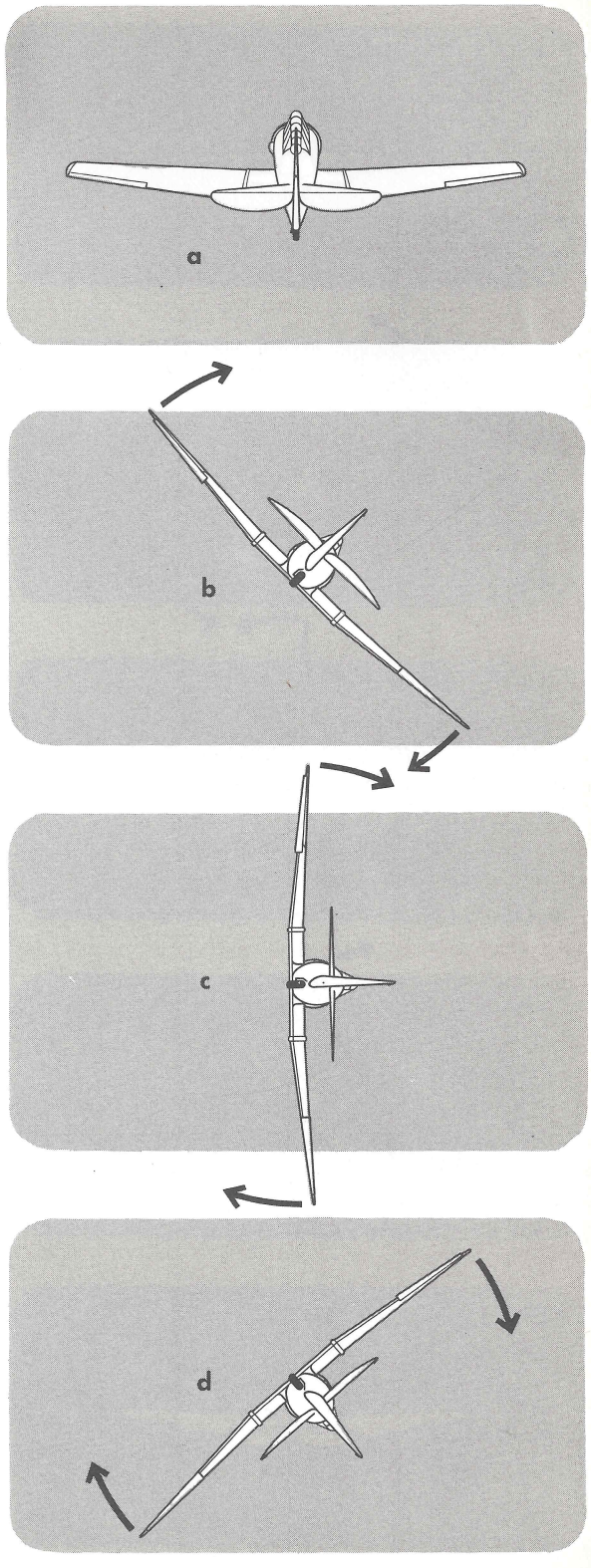
These control pressures should be blended in smoothly and coordinated to maintain directional control and to cause the aircraft to roll level as the straight and level flight attitude



Slow Roll

is reached. Remember that this pitch attitude will be slightly higher than the cruising straight and level flight attitude because of the low airspeed at the completion of the maneuver.

To recover in straight and level flight, you must start the roll without hesitation or delay when the nose is still slightly above the horizon. Remember that the roll is executed with the aileron. The rudder and elevators are used to maintain the correct heading and nose position in regard to the horizon. Do not attempt to force the roll with the rudder or elevators, as this will cause the aircraft to skid excessively and the nose to change direction.



a. SLIGHT BACK ELEVATOR PRESSURE.
RUDDER NEUTRAL.
AILERON NEUTRAL.
ATTAIN 3 POINT PITCH ATTITUDE.
START ROLL WITH COORDINATED STICK AND RUDDER PRESSURES.

b. RELAX A SLIGHT BIT OF BACK ELEVATOR PRESSURE.
CROSS RUDDER (RIGHT STICK LEFT RUDDER)
AILERON ROLLING AIRCRAFT.
RUDDER AND ELEVATOR HOLDING POINT.

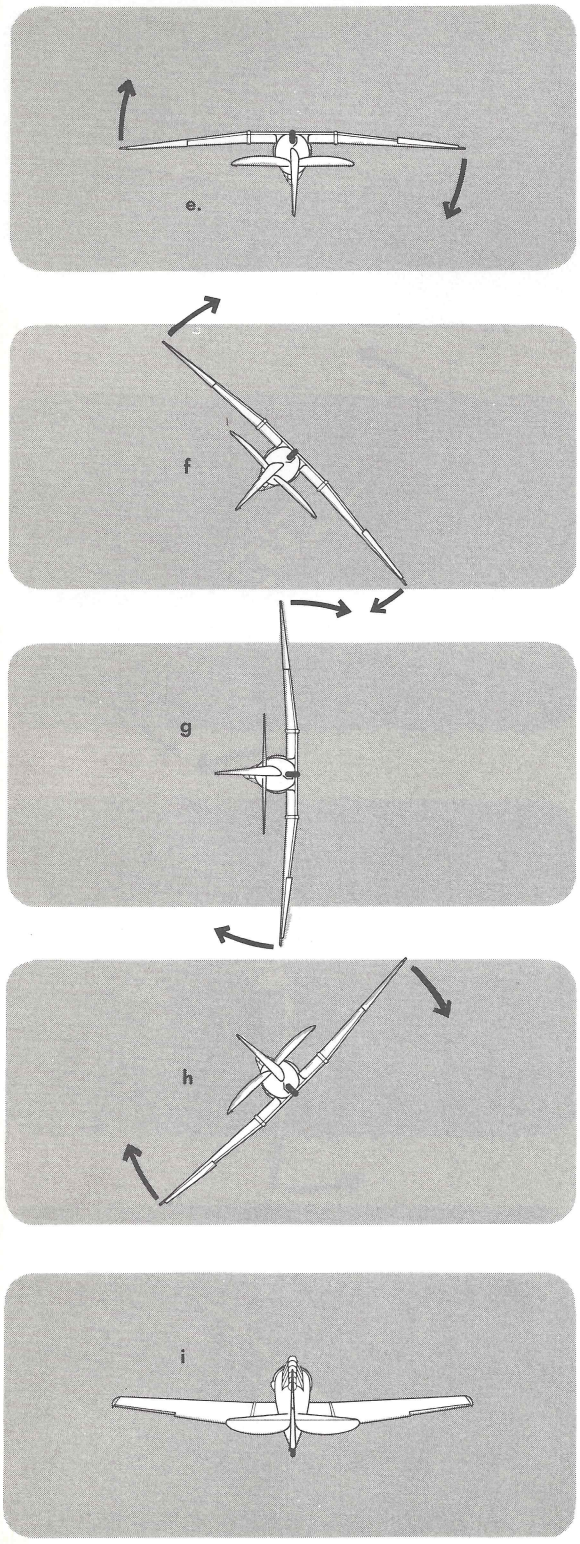
c. ELEVATORS APPROXIMATELY NEUTRAL AND STICK MOVING FORWARD.
TOP RUDDER INCREASED.

d. FORWARD STICK PRESSURE INCREASING.
TOP RUDDER DECREASING SLIGHTLY.

This maneuver should be practiced both to the right and to the left.

SLOW ROLL

A slow roll is a maneuver in which the aircraft is rolled through 360 degrees around its longitudinal axis by use of ailerons. The rudder and elevators are used to maintain directional control and to keep the nose of the aircraft on a point above the horizon. The safety belt



should be tight, and all equipment secure as you will be suspended by your safety belt while executing this maneuver.

Begin the maneuver by making at least two 90° clearing turns. Attain the initial speed, which is 160 MPH, by diving the aircraft slightly through the second clearing turn.

When you reach a speed of 160 MPH, slowly and smoothly raise the nose to the three-point attitude with the elevators, holding the wings level with the ailerons. When this attitude is attained, start a roll by applying coordinated

e. MOST FORWARD STICK NEEDED.
SLIGHT AMOUNT OF SAME RUDDER HELD AS USED TO THIS POINT.

f. FORWARD STICK PRESSURE RELAXING SLIGHTLY.
RUDDER NEUTRALIZED AND CROSSED BETWEEN THIS AND PRECEDING POINT (TOP RUDDER IS NOW SAME AS STICK)

g. FORWARD STICK RELAXING TOWARD NEUTRAL.
MOST TOP RUDDER, NEEDED.
BEGIN RELAXING AILERON PRESSURE.
1. AILERON DRAG ON LOW WING WILL PULL THE NOSE DOWN.

h. BLEND IN BACK STICK PRESSURE TO KEEP NOSE FROM DROPPING

i. BACK ELEVATOR PRESSURE AND SLIGHT RUDDER TO HOLD POINT.
AILERONS CROSSED SLIGHTLY TO RUDDER TO PREVENT OVERROLLING AND TO KEEP WINGS LEVEL GRADUALLY FLY OUT OF SLIGHT SKID.

pressures on the stick and rudder as in the beginning of a turn. This means aileron and rudder are in the same direction. If the roll was started with the aileron alone, or by crossing the controls, the adverse yaw, or aileron drag would cause the nose to swing off the point.

As the aircraft begins to roll, the nose will stay on the point. As the bank increases, however, the nose will begin to drop and swing off the point. At this moment you should begin easing off the pressure on the rudder and begin gradually applying opposite — or top —

rudder. At the same time you should begin blending in a slight forward-stick pressure. The elevators and rudder are now being used to maintain the proper heading and to hold the point. The ailerons are rolling the aircraft.

As the vertical position is reached, the top-rudder pressure should be at a maximum; and more forward-stick pressure should be applied to counteract the turn induced by bank, and to keep the nose on the point. Continue to increase forward-stick pressure as the aircraft rolls toward the inverted position. At this instant the forward-stick pressure is at a maximum, and rudder pressure should be reduced, so it can be neutralized, and then applied in the opposite direction (the same direction as the aileron), just after the inverted position is passed.

The aircraft continues to roll until the vertical position is again reached. In this position top-rudder pressure is again at the maximum in order to maintain the nose attitude above the horizon, and the elevators are used to keep the aircraft on the correct heading.

You must apply aileron pressure throughout the maneuver as is necessary to maintain a constant roll, but you must gradually relax the aileron pressure throughout the last 90 degrees of roll to prevent "dishing out." You must also relax forward-stick pressure during the last 90 degrees of roll and gradually apply back-stick pressure to keep the nose on the point.

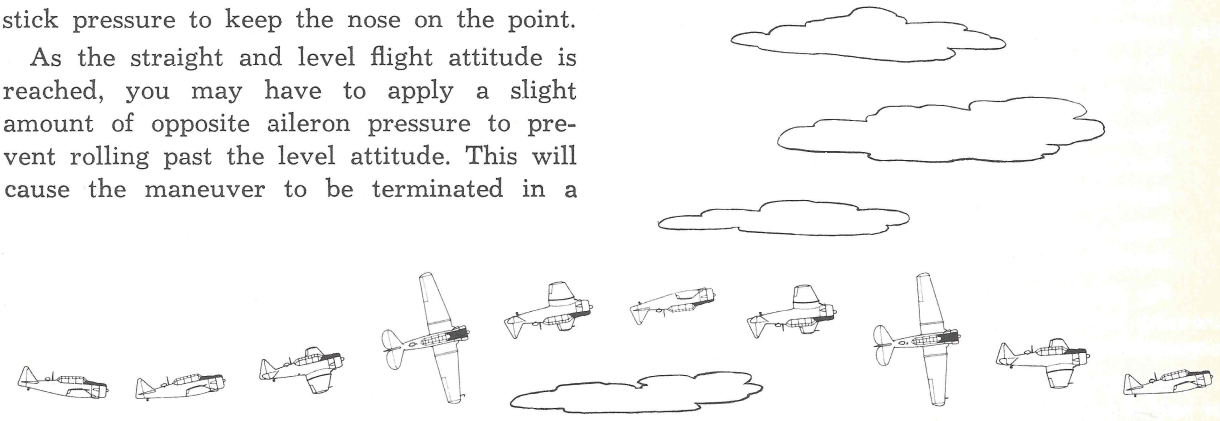
As the straight and level flight attitude is reached, you may have to apply a slight amount of opposite aileron pressure to prevent rolling past the level attitude. This will cause the maneuver to be terminated in a slight skid; gradually fly the aircraft out of the skid.

The reason for relaxing some of the aileron pressure in the last 90 degrees of the roll is to reduce the aileron drag on the low wing. If too much aileron is being applied at this point, the rudder cannot maintain a nose-high attitude and compensate for the excessive aileron drag on the low wing, resulting in the nose's "dishing out."

This maneuver is started and completed with the nose in the three-point attitude, and it should remain on this point throughout the entire maneuver. If the maneuver is executed properly, altitude will not be lost but will be maintained and in some instances it will be gained.

Remember that the rudder and elevators are used to maintain directional control as well as nose position above the horizon during the roll. The conception of having the ailerons as the major control is important, as most of the errors committed during the performance of the maneuvers are the result of attempting to force the roll with the rudder and over controlling with the elevators.

This maneuver should be practiced both to the right and to the left.



Half-roll and Reverse

HALF-ROLL AND REVERSE

The half-roll and reverse is a maneuver in which the aircraft is rolled around the longitudinal axis until it is completely inverted, and then rolled back to level flight in the opposite direction.

Begin this maneuver by making at least two 90° clearing turns. Attain the initial speed, which is 160 MPH, by diving slightly through the second clearing turn.

When you reach a speed of 160 MPH, slowly and smoothly raise the nose to the three-point attitude with the elevators, holding the wings level with the ailerons. When this attitude is attained, begin a coordinated roll with stick and rudder pressures as in the beginning of a turn. The first half of the roll will now be accomplished in exactly the same manner as is the first half of the slow roll.

You must anticipate the inverted position, gradually reducing aileron pressures until they are neutralized as this position is reached. This will prevent rolling past the inverted position. Hold a sufficient amount of rudder pressure to maintain directional control, and a maximum amount of forward-stick pressure to hold the nose above the horizon on the original point.

Do not hesitate in the inverted position. As it is reached, you must immediately begin applying aileron in the opposite direction of the original roll, and top rudder to hold the nose above the horizon and on the point. Lead the roll slightly with the stick, and then follow with the rudder. The time it takes to reverse the controls and start the roll-back gives the momentary hesitation in the inverted position to make the maneuver correct; this should be done without a conscious effort to hesitate.

The roll-back to level flight is the same as in the last half of the slow roll. Remember to relax some aileron pressure through the last 90 degrees of roll to prevent "dishing out."

The maneuver is started and completed with the nose in the three-point attitude, and it should remain on this point throughout the entire maneuver. If the maneuver is executed properly, altitude will not be lost, but will be maintained and in some instances will be gained

Things To Remember

Be sure to clear the area thoroughly before beginning any acrobatic maneuver, because there is usually a considerable change in altitude and attitude in most maneuvers; it is difficult to see other aircraft while controlling your aircraft in abnormal attitudes.

The initial maneuver speed is attained by diving through the second clearing turn.

The power setting for all acrobatics is 25″ Hg and 1850 RPM. The throttle remains constant throughout the maneuver.

Do not lead the airspeed for the initial entry into the maneuver; wait until the proper airspeed is reached.

The following airspeeds apply for each maneuver:

Barrell Roll	160 MPH
Slow Roll	160 MPH
Half-Roll and Reverse	160 MPH
Loop	190 MPH
Immelmann	200 MPH

For all vertical acrobatics, allow the nose to rise slowly and smoothly to the horizon, and then begin increasing back-stick pressure. The nose should continue to move at a constant rate. If the maneuver is correctly accomplished, definite seat pressures will be maintained throughout the maneuver.

In any rolling maneuver, the ailerons roll the aircraft, and the rudder and elevators maintain coordination or hold a point. Remember to apply sufficient aileron pressure to maintain a constant rate of roll.

Trim the aircraft for straight and level cruising speed, not for the acrobatic maneuver.

Use ground references for orientation whenever possible.

The minimum altitude for entry, performance, and recovery for all acrobatic maneuvers is 5000 feet above the terrain.